SF-RAD:

Wastewater Based Epidemiology Beyond the COVID-19 Pandemic: Opportunities and Next Steps

Funded by

RADx Radical

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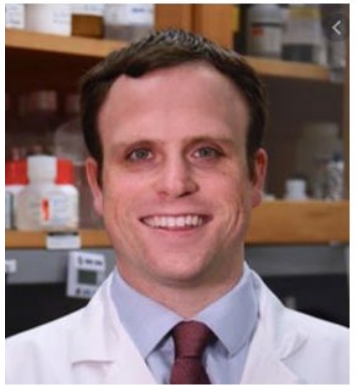
RADXUP

1OT2HD108111(Suppl, Gwynn)

4Catalyzer

UNIVERSITY OF MIAMI

Weill Cornell Medicine



Helena Stephan Chris

PIs: Helena Solo-Gabriele, Stephan Schürer, Chris Mason,

Professor, UMiami

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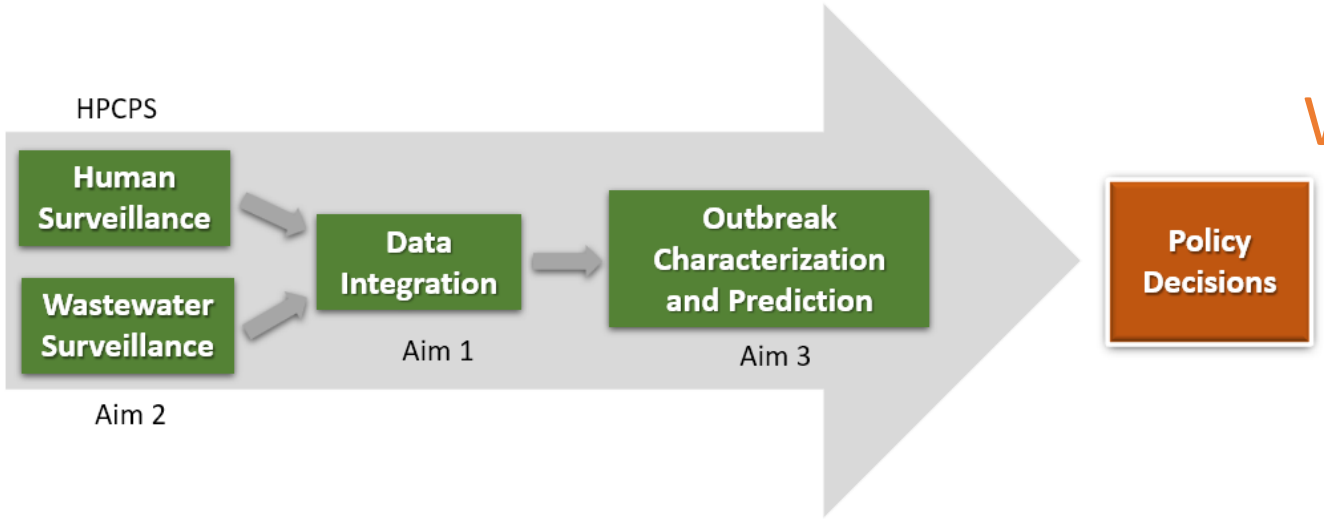
Aims

1. Data standardization and informatics infrastructure
2. Wastewater characterization
3. Integration with human health surveillance



SARS-CoV-2 Wastewater-Based Surveillance

www.covidsfrad.org

Acknowledgments

Questions (hmsolo@miami.edu)

UM Leadership
President Frenk
Dr. Erin Kobetz
George Grills

Facilities, Med.
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- Ismael Berejano

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- City Miami Police

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- Tom Stone
- Sam Comerford

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- Stephanie Duffort

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Center for AIDS Res.
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- Dr. Mark Sharkey

Onco-Genomics Lab
- Dr. Sion Williams
- Benjamin Currall

Weill Cornell Lab
- Dr. Chris Mason
- Krista Ryon
- Jonathan Foox
- Braden Tierney

Miami-Dade Water & Sewer Dept

Sylvester Comprehensive Cancer Center

COVID-19 brought Clinical and Environmental Researchers Together

SYLVESTER COMPREHENSIVE CANCER CENTER
UNIVERSITY OF MIAMI HEALTH SYSTEM

George Grills: Director of Share Resources

- Behavioral and Community-Based Research Shared Resource (BCSR)
- Biospecimen Shared Resource (BSSR)
- Onco-Genomics Share Resource (OGSR)

UHealth
UNIVERSITY OF MIAMI HEALTH SYSTEM

Division of Infectious Disease

THE MIAMI CENTER FOR AIDS RESEARCH
CFAR
UNIVERSITY OF MIAMI
MILLER SCHOOL OF MEDICINE

MIAMI MILLER SCHOOL of MEDICINE

Ethics Institute
Dept. of Public Health Sciences
Biostatistics Consulting Core
Dept. of Molecular & Cellular Pharmacology

MIAMI COLLEGE of ENGINEERING

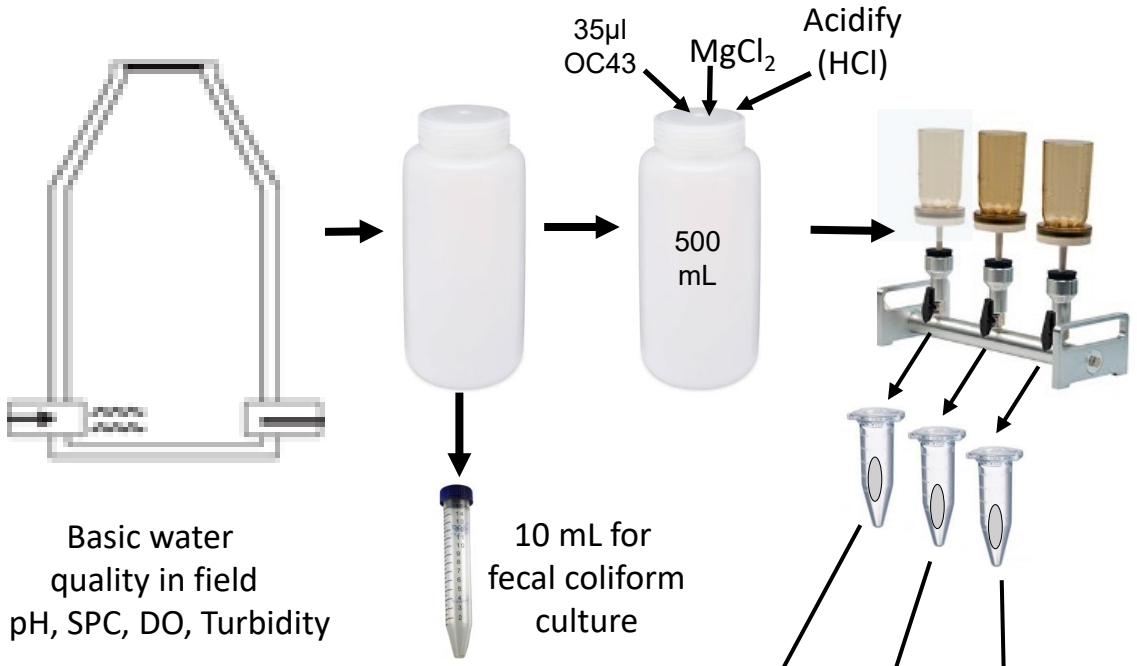
Dept. of Chem, Environmental, & Materials Eng.

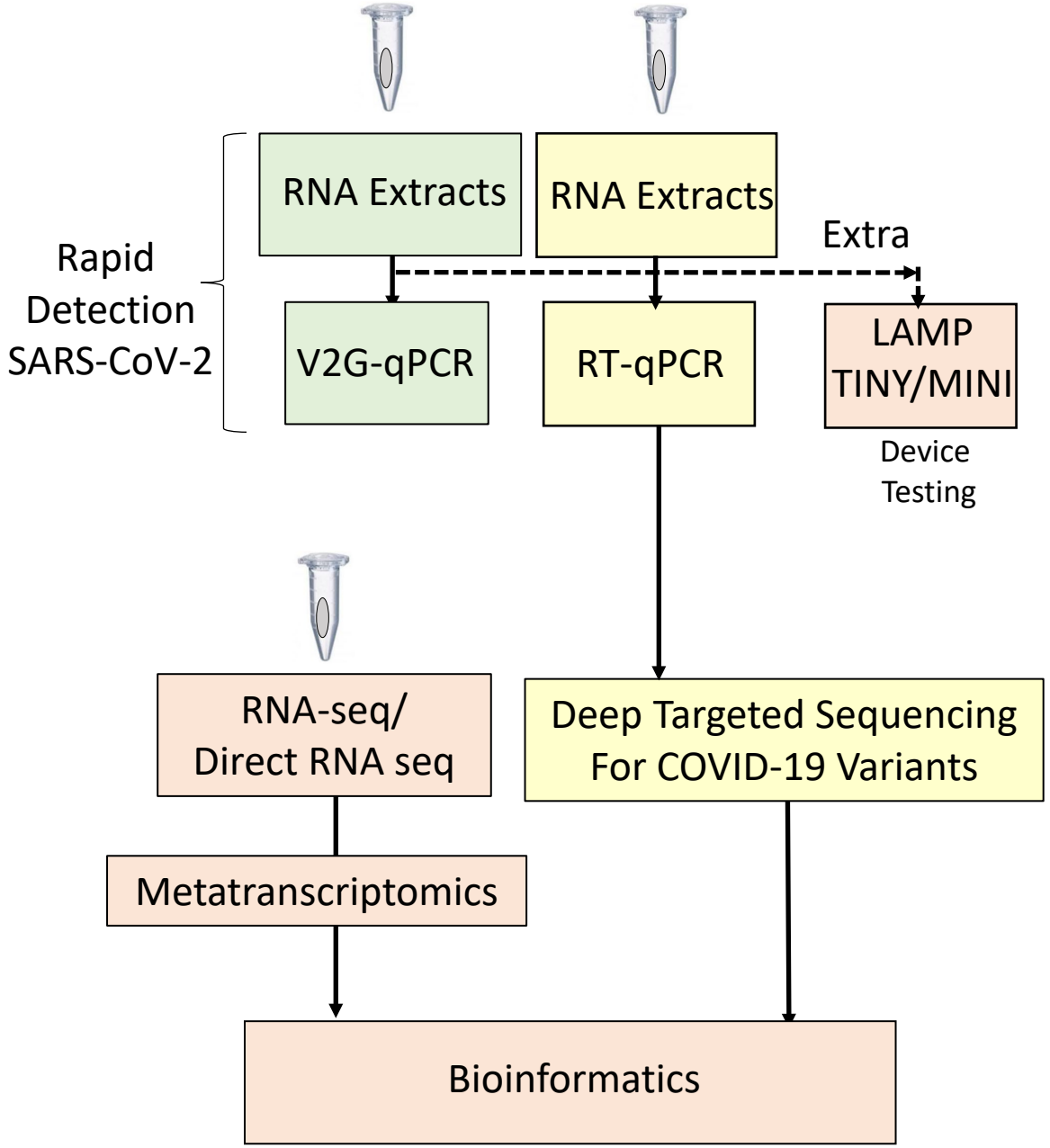
Weill Cornell Medicine

Dept. of Physiology & Biophysics

MetaSUB

Sample Analysis Plan





Mark Sharkey,
Center for AIDS Research, UM

Sion Williams
Onco-Genomics Shared Resource, UM

Chris Mason,
Integrated Genomics Lab, WCM/MetaSub

Human Surveillance

Student Campus Residents, UMiami Gables/Marine (Sep. 2020)

Fall'20/Spring'21

- Students tested weekly (nasal swab, qPCR) Supplemented by breath test
- COVID results and total tests by building/dorm room

Summer/Fall'21

- Unvaccinated students tested weekly
- All students tested when wastewater exceeds

University Hospital, UMiami Medical (Sep. 2020)

- Treat known COVID patients
- Electronic medical records pulled regularly

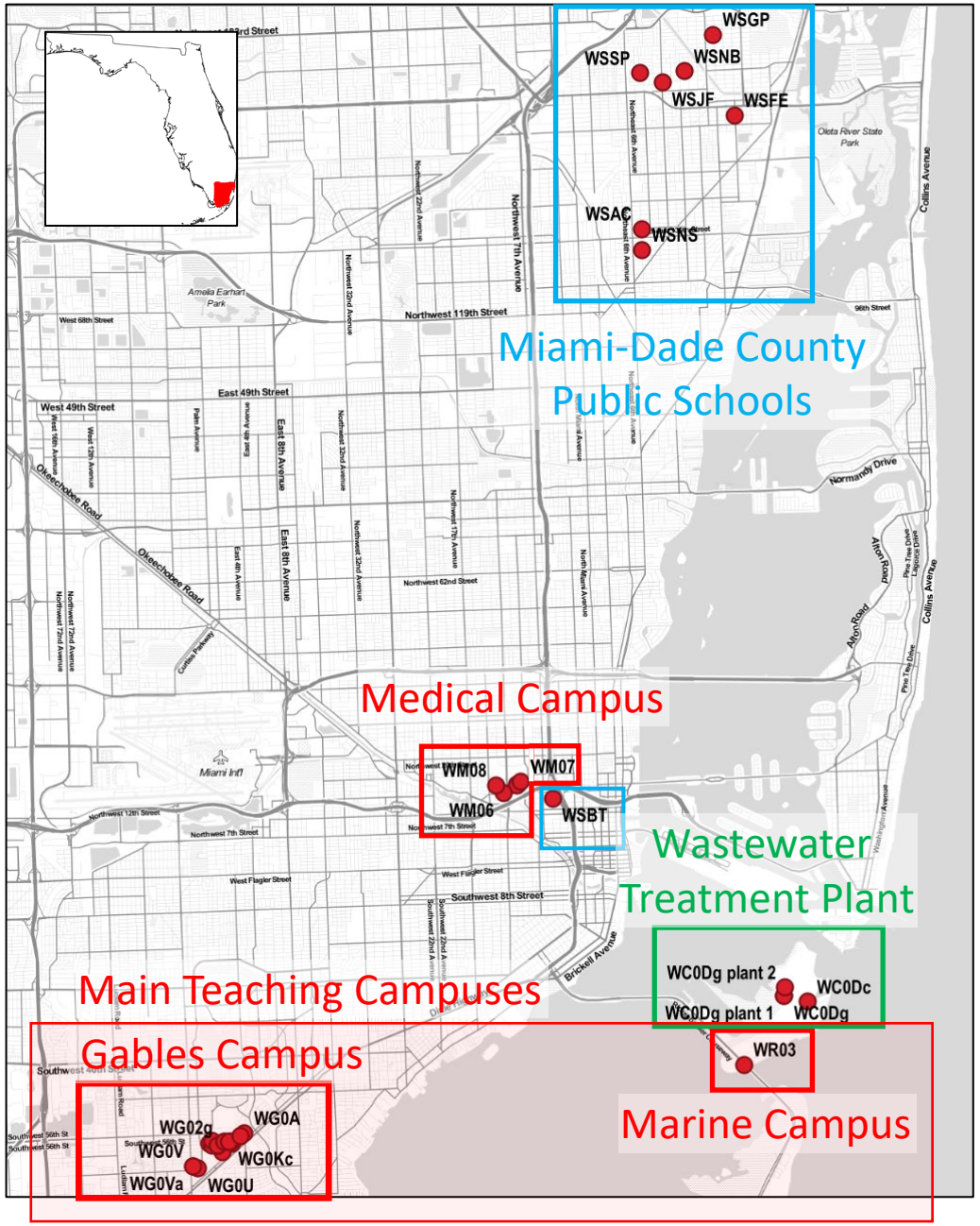
Miami-Dade County Residents, FDOH WWTP (Jan. 2021)

- Positives by zip code
- Number of tests by zip code
- Augment with Biobot wastewater data (Apr. 2020)

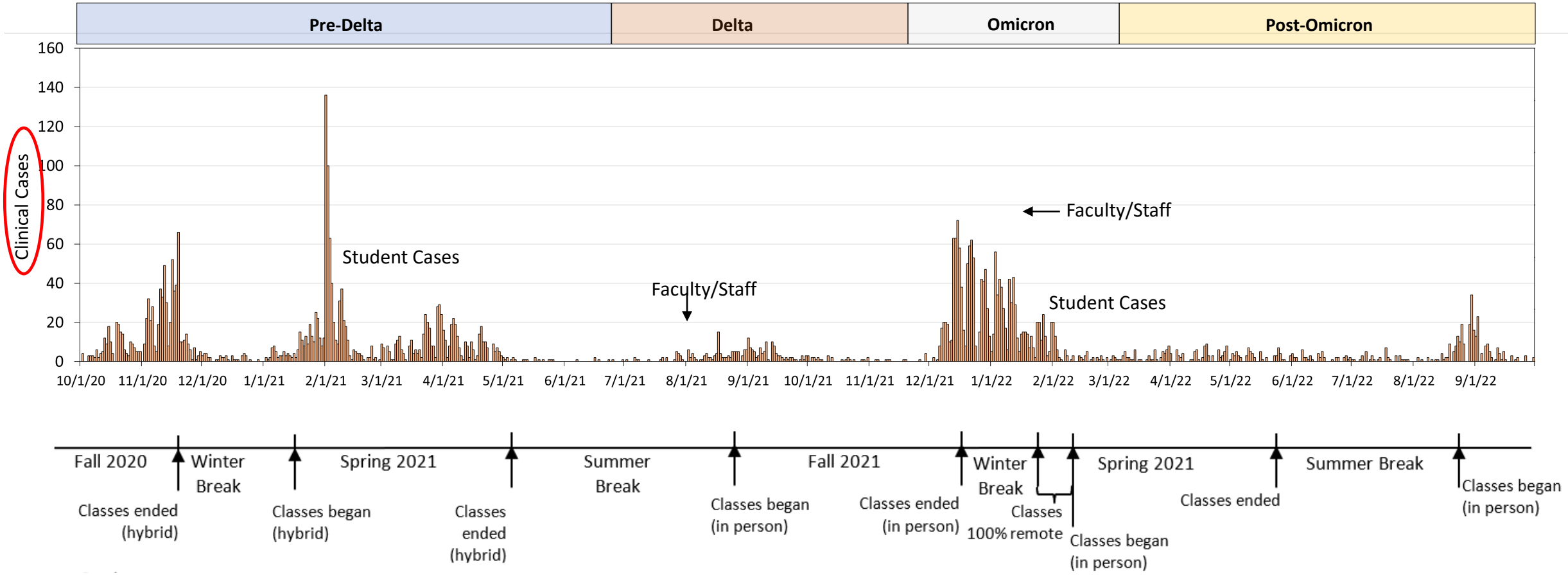
Pilot, **Miami-Dade County Public Schools**, MDCPS (Jan. 2022)

- In collaboration with RADx-UP project (Gwynn, PI)
- 9 Schools (4 Elementary, 2 Middle, 3 High Schools)

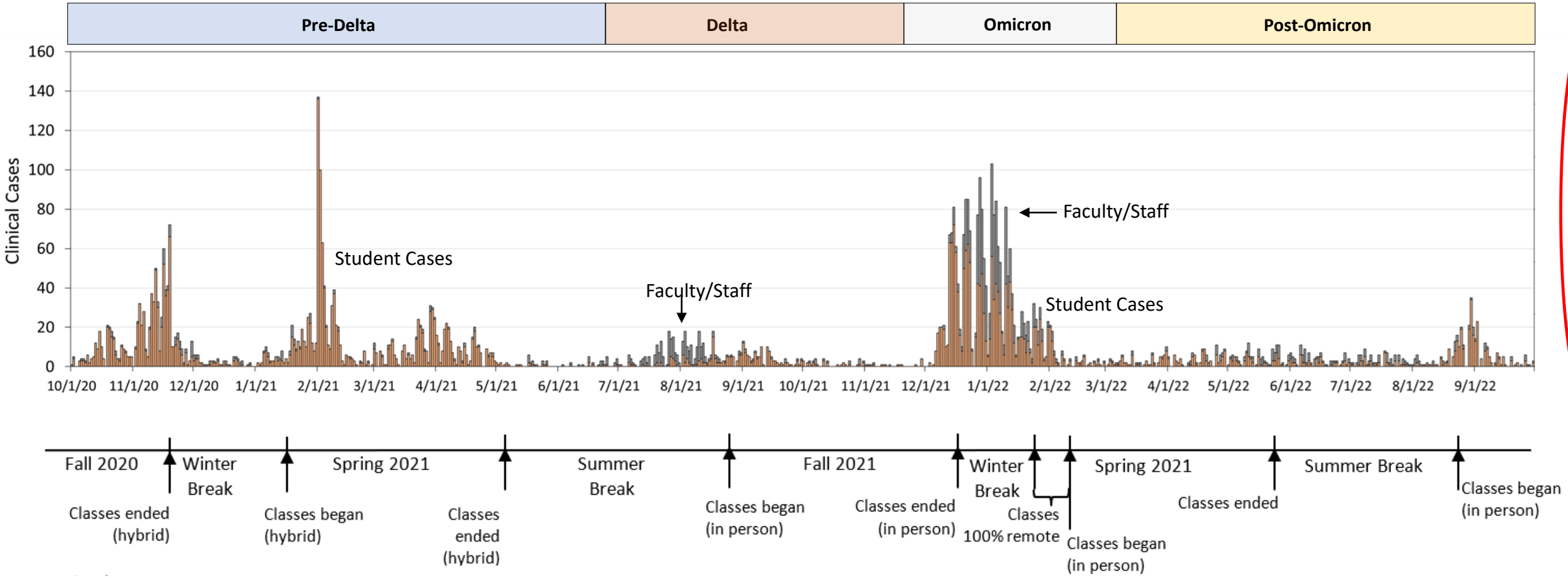
Sample Collection Plans



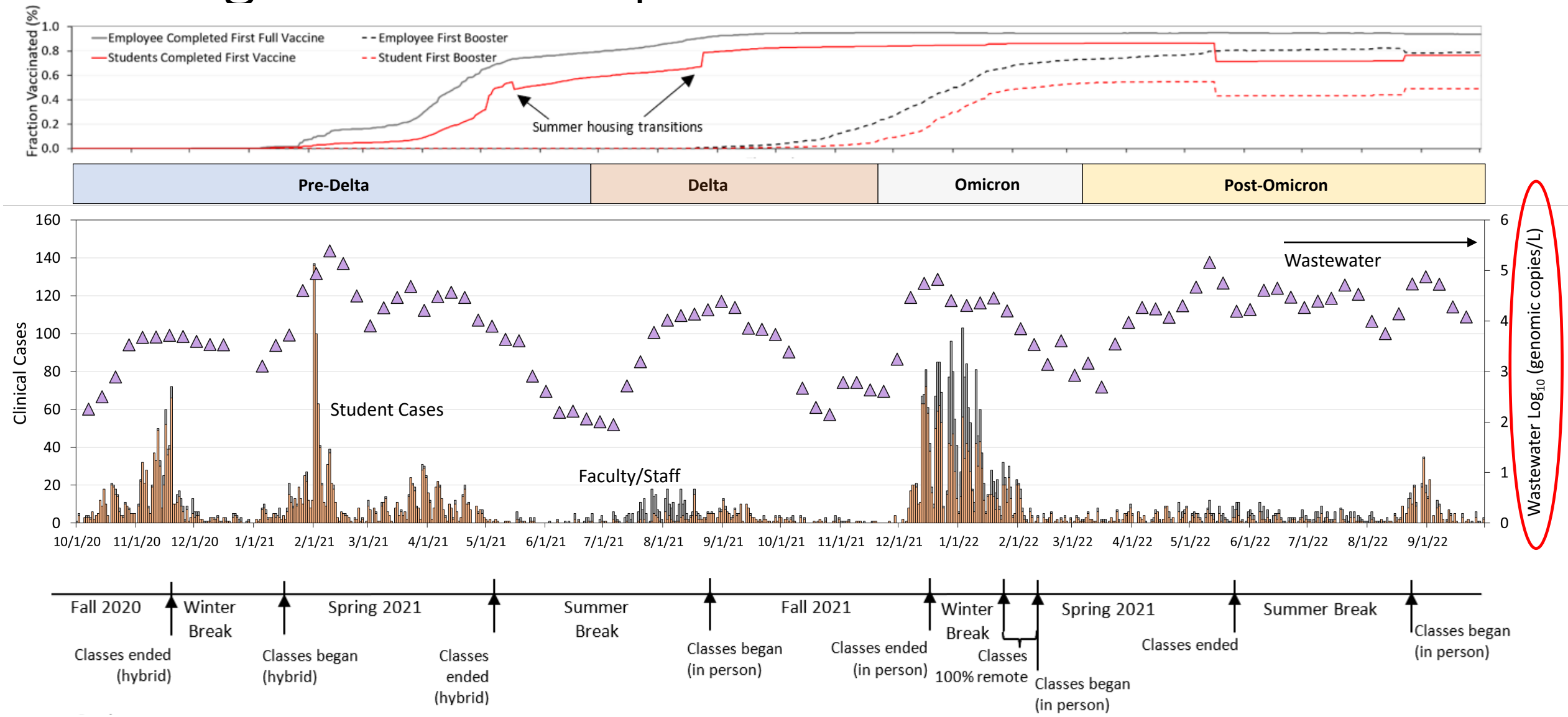
Undergraduate Campus



Undergraduate Campus

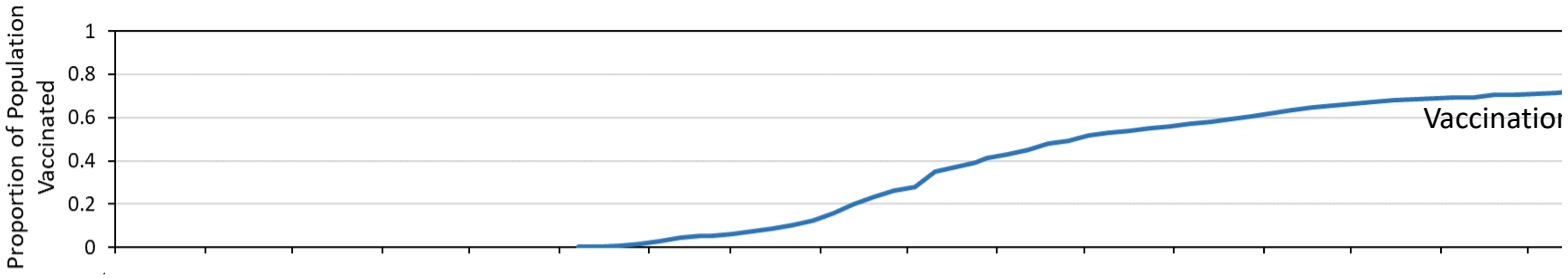


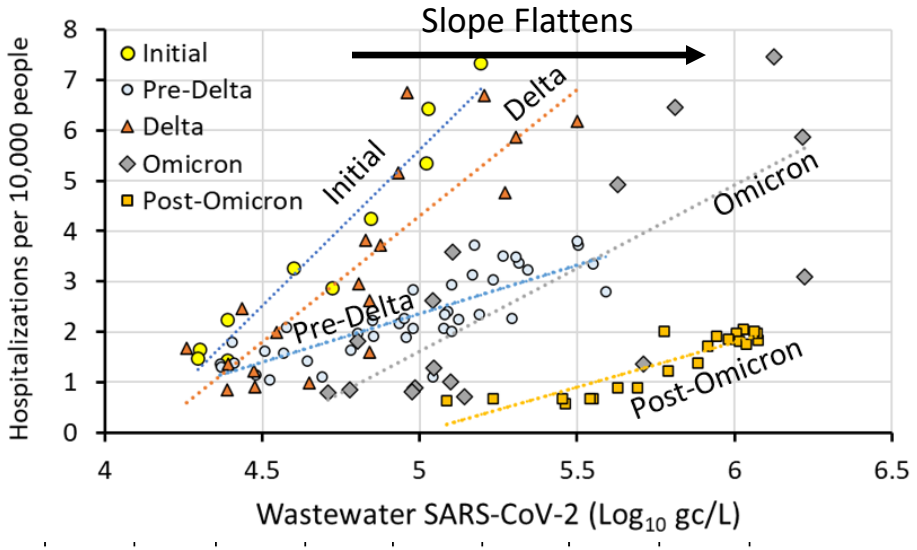
Undergraduate Campus

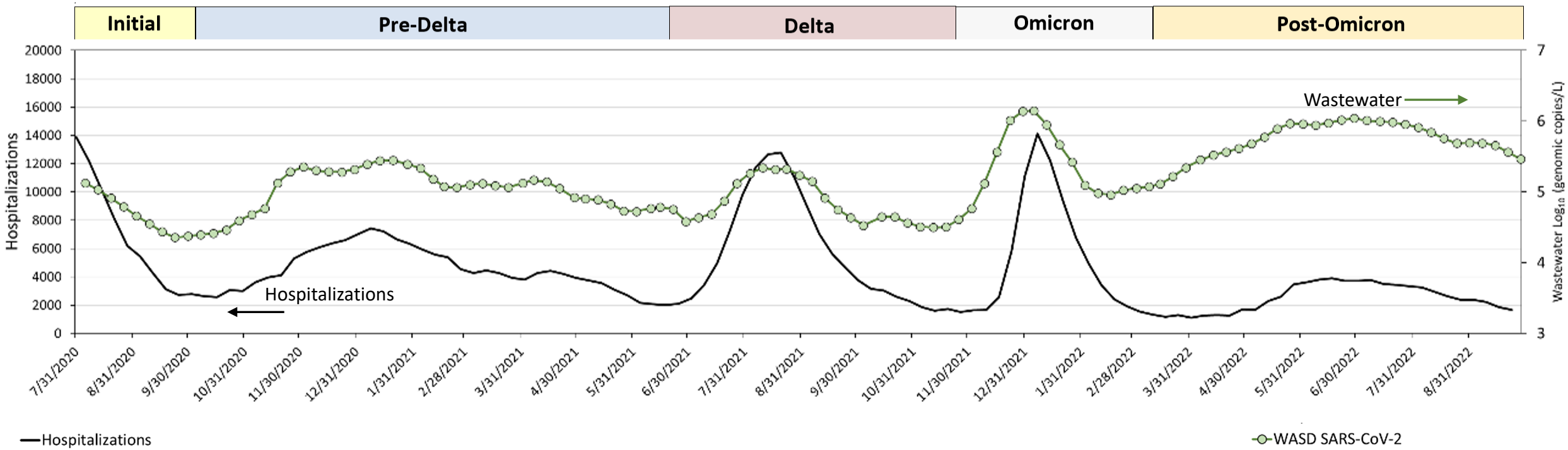


Hospitalizations

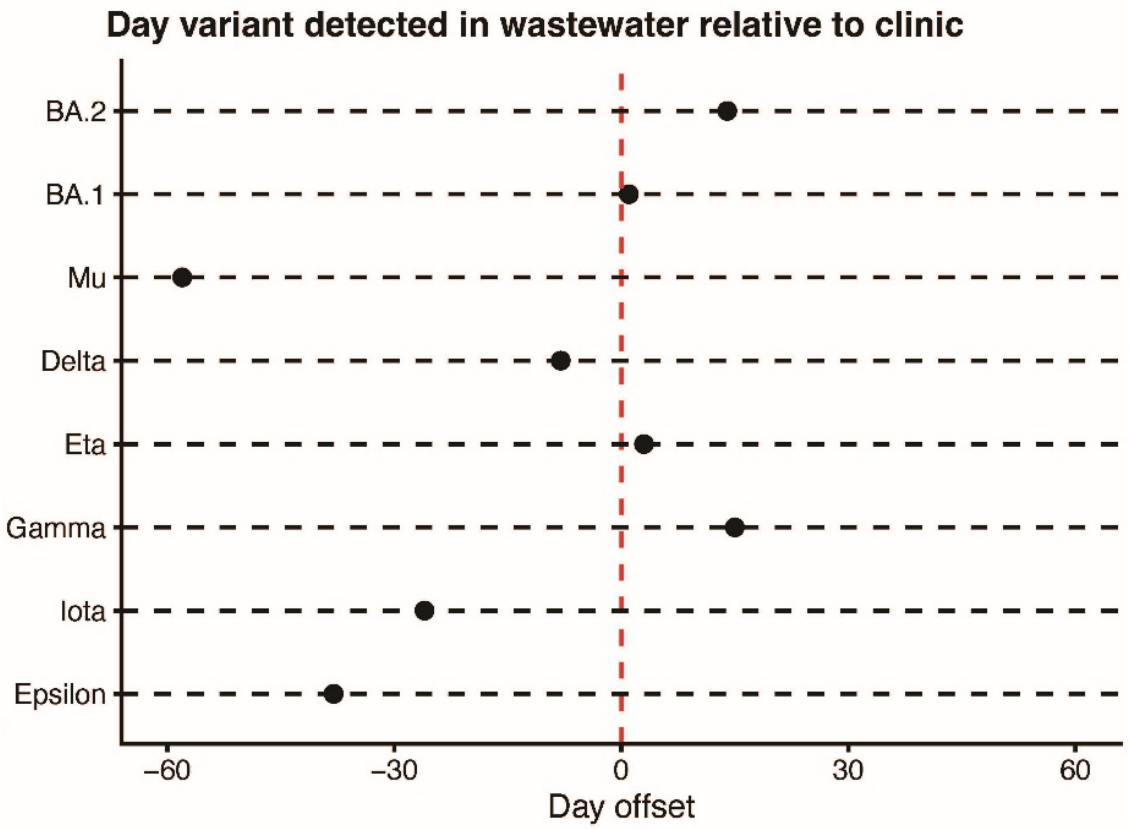
Hospitalizations

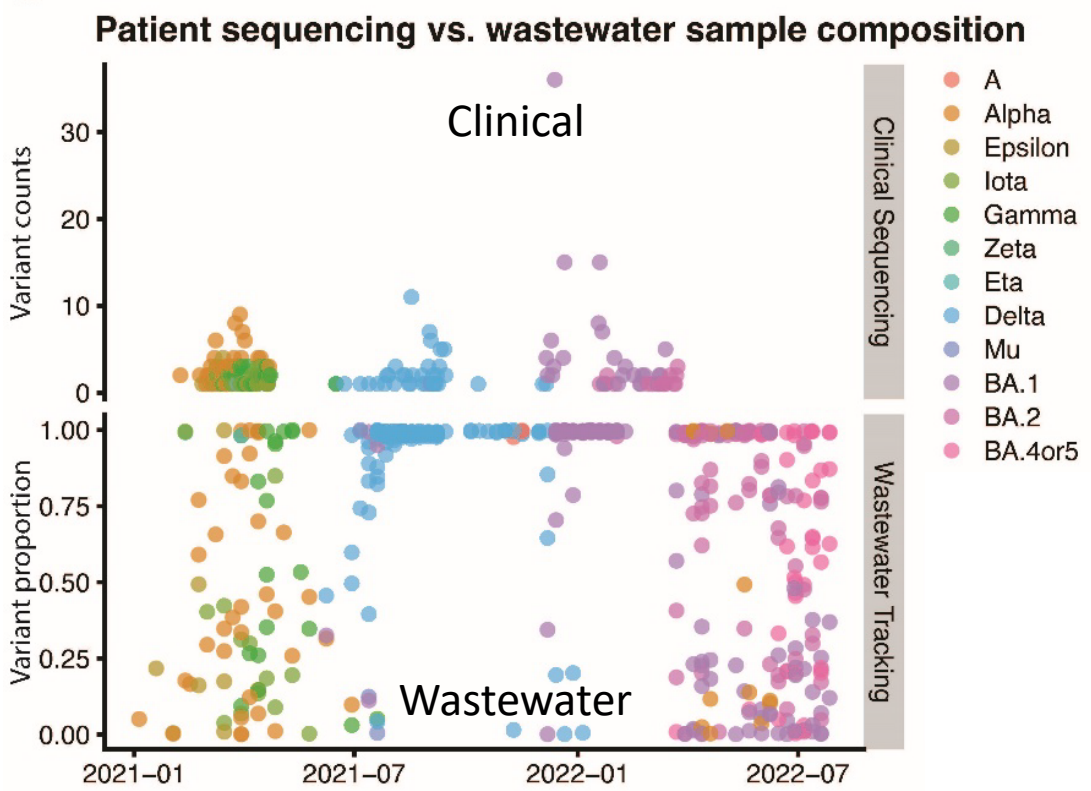






Detection and anticipation of SARS-CoV-2 Variants of Concern (VOCs) in wastewater with amplicon NGS





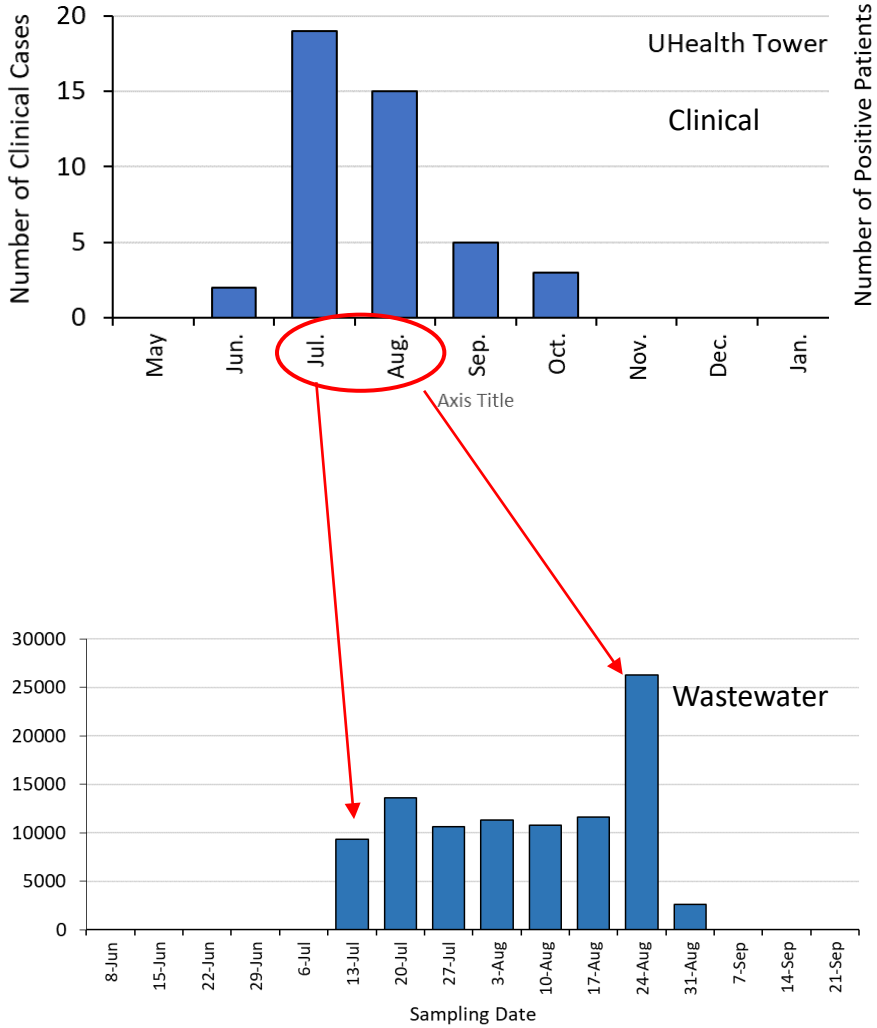
ARCTIC amplicon preparation and Illumina NovaSeq6000 NGS

Hospital Wastewater

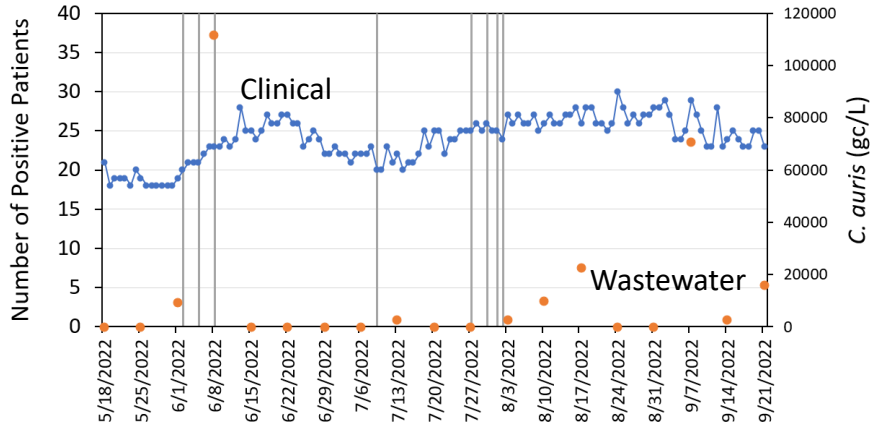
Comorbidities

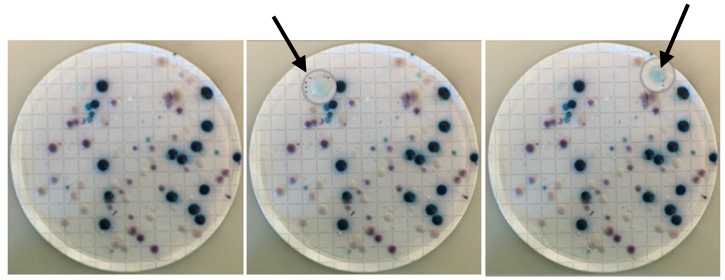
	Delta	Omicron	Omicron subvariants
	Lab1	Lab1	Lab1
Lab1	1.00	1.00	1.00
Male gender	-0.14	0.04	0.16
Ventilator use	-0.37	-0.81	-0.23
Admission to critical care unit	-0.50	-0.73	0.23
Cancer diagnosis	-0.24	0.25	0.14
Cardiovascular disease	-0.76	-0.39	0.02
Immunosuppressive condition	0.37	-0.60	0.43
Nicotine use	-0.75	0.04	0.17
Asthma	-0.10	-0.02	-0.13
Chronic kidney disease	-0.34	-0.77	0.62
Chronic lung disease	0.19	-0.19	-0.10
Diabetes	-0.46	-0.35	0.17
Hypertension	-0.87	0.01	0.17
Remdesivir administration	0.76	-0.03	-0.08
Inpatient mortality	0.06	-0.21	-0.31
Number of inpatients	0.69	0.75	0.18
Age	-0.66	-0.30	0.24
Duration of hospitalization (days)	-0.71	-0.37	0.01

Mpox



Candida auris



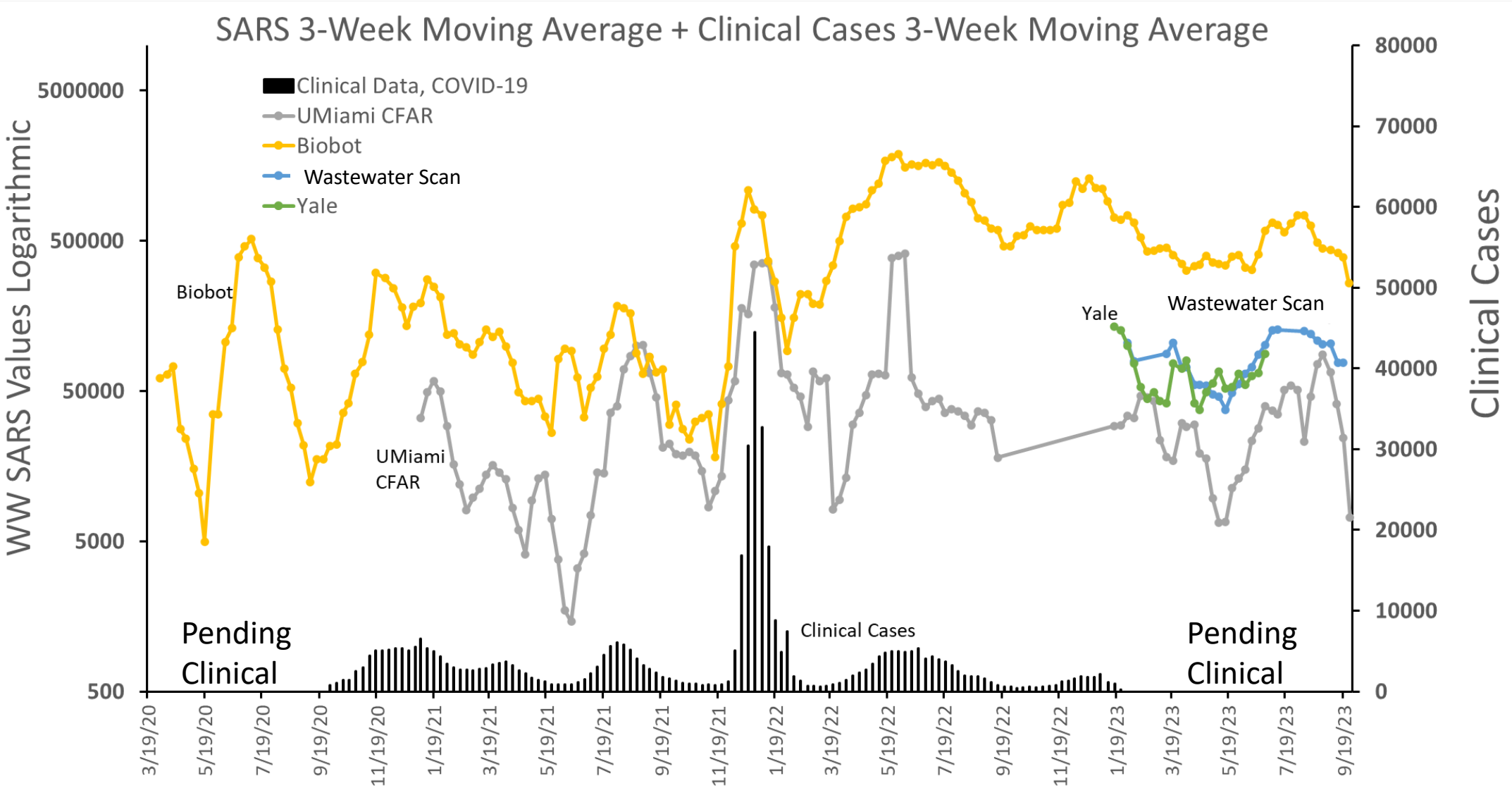


Candida auris cultured from wastewater

Next Steps

Additional Targets

	UMiami CFAR	Yale	Wastewater Scan	Biobot
SARS-CoV-2	X	X	X	X
SARS (Omicron)			X	
PMMoV	X		X	X
Influenza A/B	X	X	X	
Poliovirus	X			
RSV	X	X	X	
Norovirus GI/GII		X	X	
Mpox		X	X	
Human Metapneumovirus		X	X	
Candida auris	X		X	


SARS 3-Week Moving Average + Clinical Cases 3-Week Moving Average
Clinical Data, COVID-19
UMiami CFAR
Biobot
Wastewater Scan
Yale
WW SARS Values Logarithmic
Clinical Cases
5000000
500000
50000
5000
500
80000
70000
60000
50000
40000
30000
20000
10000
0
Biobot
UMiami CFAR
Yale
Wastewater Scan
Pending Clinical
Clinical Cases
Pending Clinical
3/19/20
5/19/20
7/19/20
9/19/20
11/19/20
1/19/21
3/19/21
5/19/21
7/19/21
9/19/21
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5/19/22
7/19/22
9/19/22
11/19/22
1/19/23
3/19/23
5/19/23
7/19/23
9/19/23

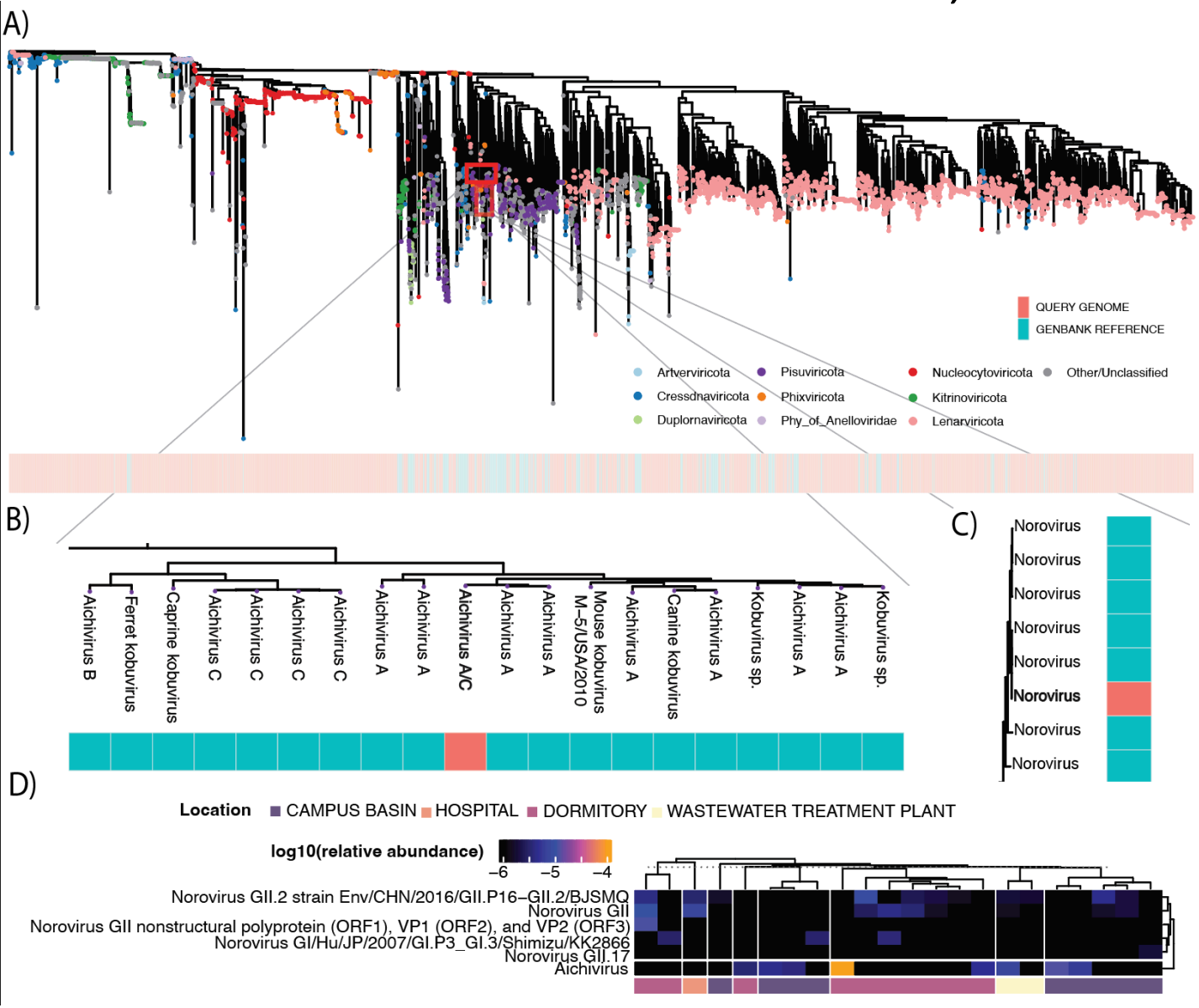
Additional Targets

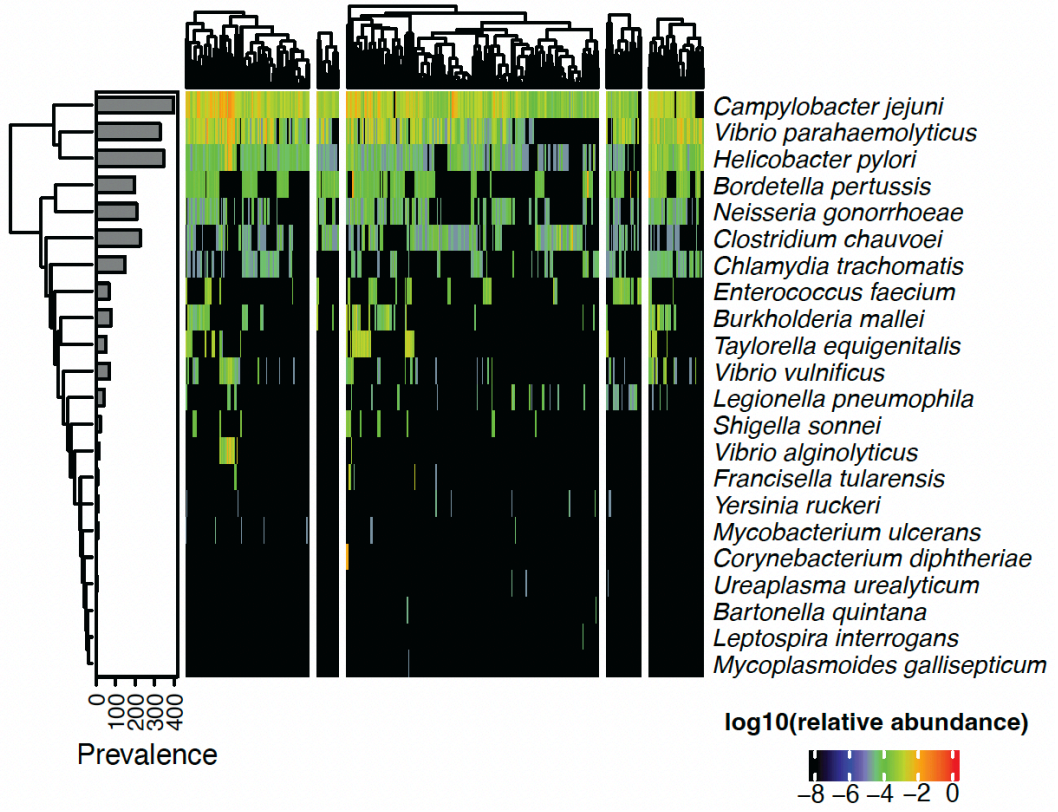
Table 1: Included on the Viral Surveillance Panel.[1]

Adenovirus	R Hepatitis B virus	Parechovirus
Aichivirus	R Hepatitis C virus	Parvovirus
Astrovirus	R Hepatitis E virus	R Poliovirus
Chapare virus	R Human Immunodeficiency Virus 1	Polyomavirus
R Chikungunya virus	Human Immunodeficiency Virus 2	Respiratory syncytial virus
Coronavirus-229E	R Influenza A virus	Rhinovirus
Coronavirus-HKU1	Influenza B virus	Rift Valley fever virus
Coronavirus-OC43	Japanese encephalitis virus	Rotavirus
Coronavirus-NL63	Junin virus	R Rubella virus
Coxsackievirus	Kyasanur Forest disease virus	Sabia virus
Crimean-congo haemorrhagic fever virus	Lassa fever virus	Salivirus
Dengue virus 1	Lujo hemorrphagic fever virus	Sapovirus
Dengue virus 2	Machupo virus	SARS-COV
Dengue virus 3	Marburg virus	R SARS-COV-2
Dengue virus 4	MERS-CoV	Tick-borne encephalitis virus
Eastern equine encephalitis virus	Metapneumovirus	Torque Teno virus
Ebola virus	Monkeypox virus	Variola virus
Enterovirus	Nipah virus	R Venezuelan equine encephalitis virus
Guanarito virus	Norovirus	R West Nile virus
Hantavirus	Omsk hemorrhagic fever virus	Western equine encephalitis virus
Hendra henipavirus	Oncolytic human papillomavirus	R Yellow fever virus
Hepatitis A virus	Parainfluenza virus	R Zika virus

Candida auris

Discovery, geography, and phylogeny of noroviruses, aichiviruses, and myriad bacteria





Direct measurements of pathogens via sequencing

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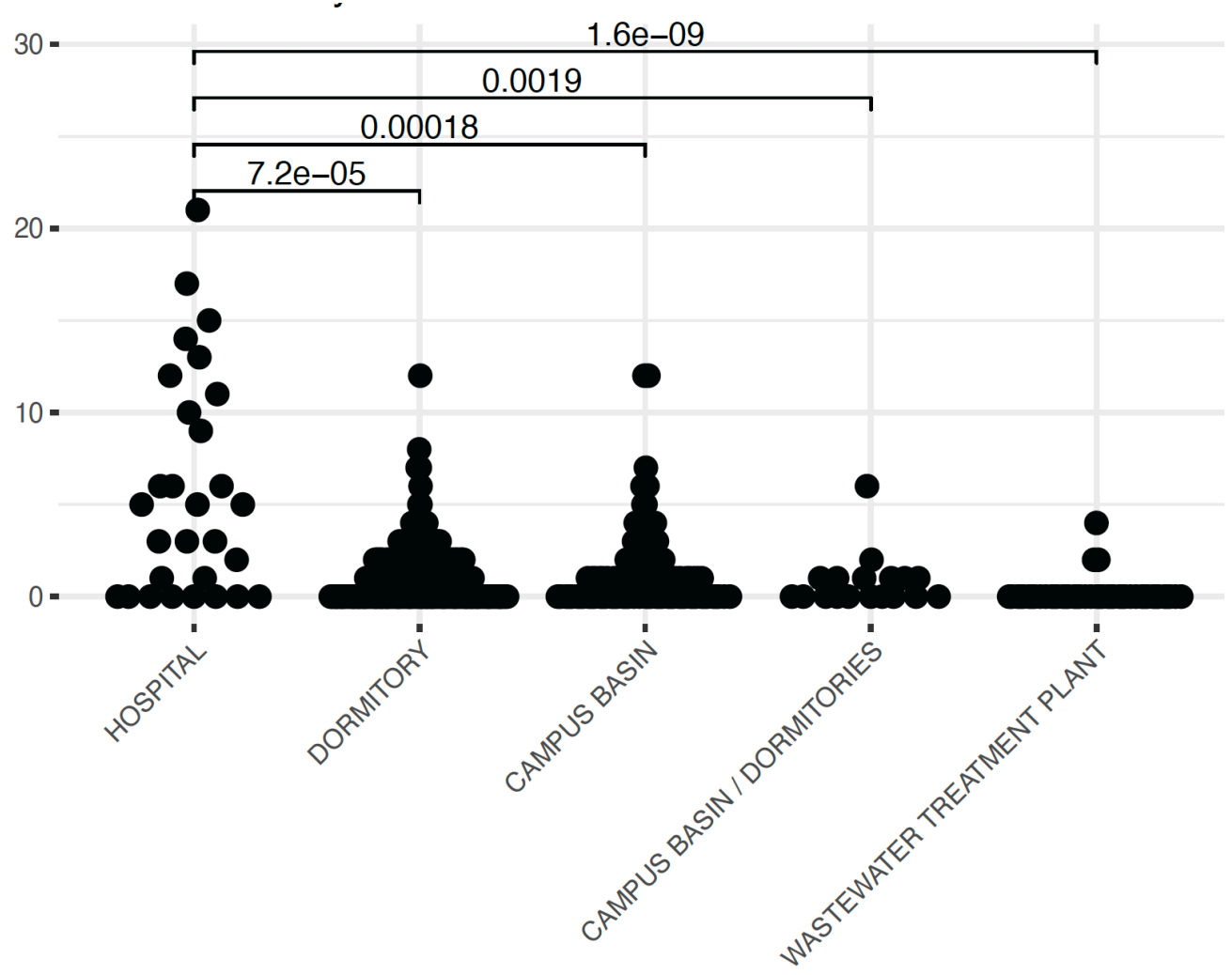
Anti-microbial resistance (AMR) genes are significantly higher in hospital sewage



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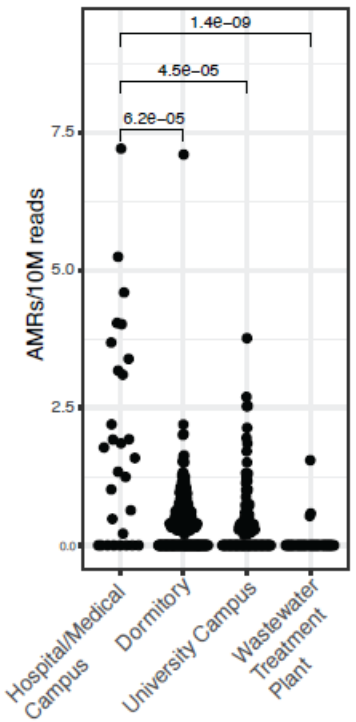
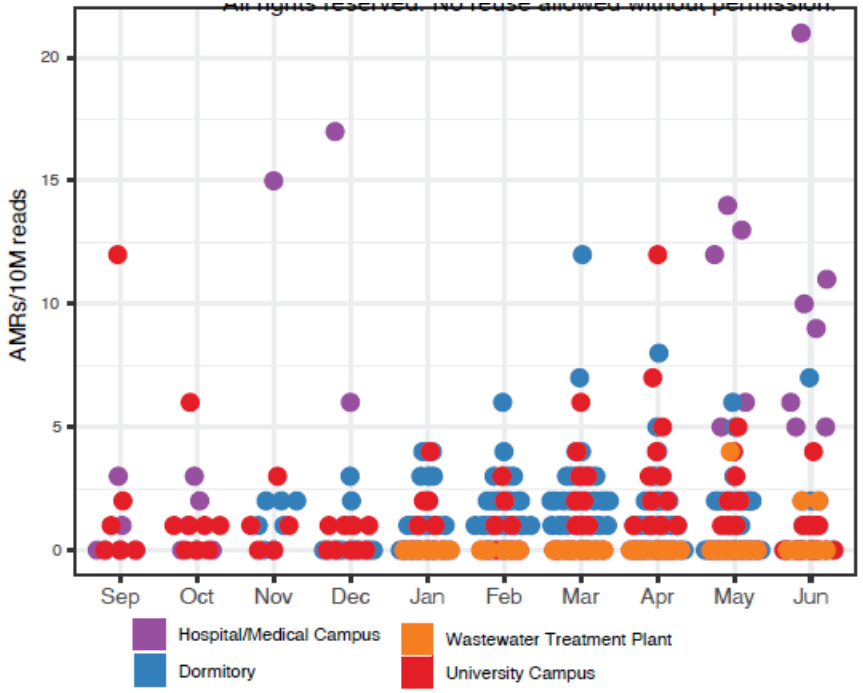
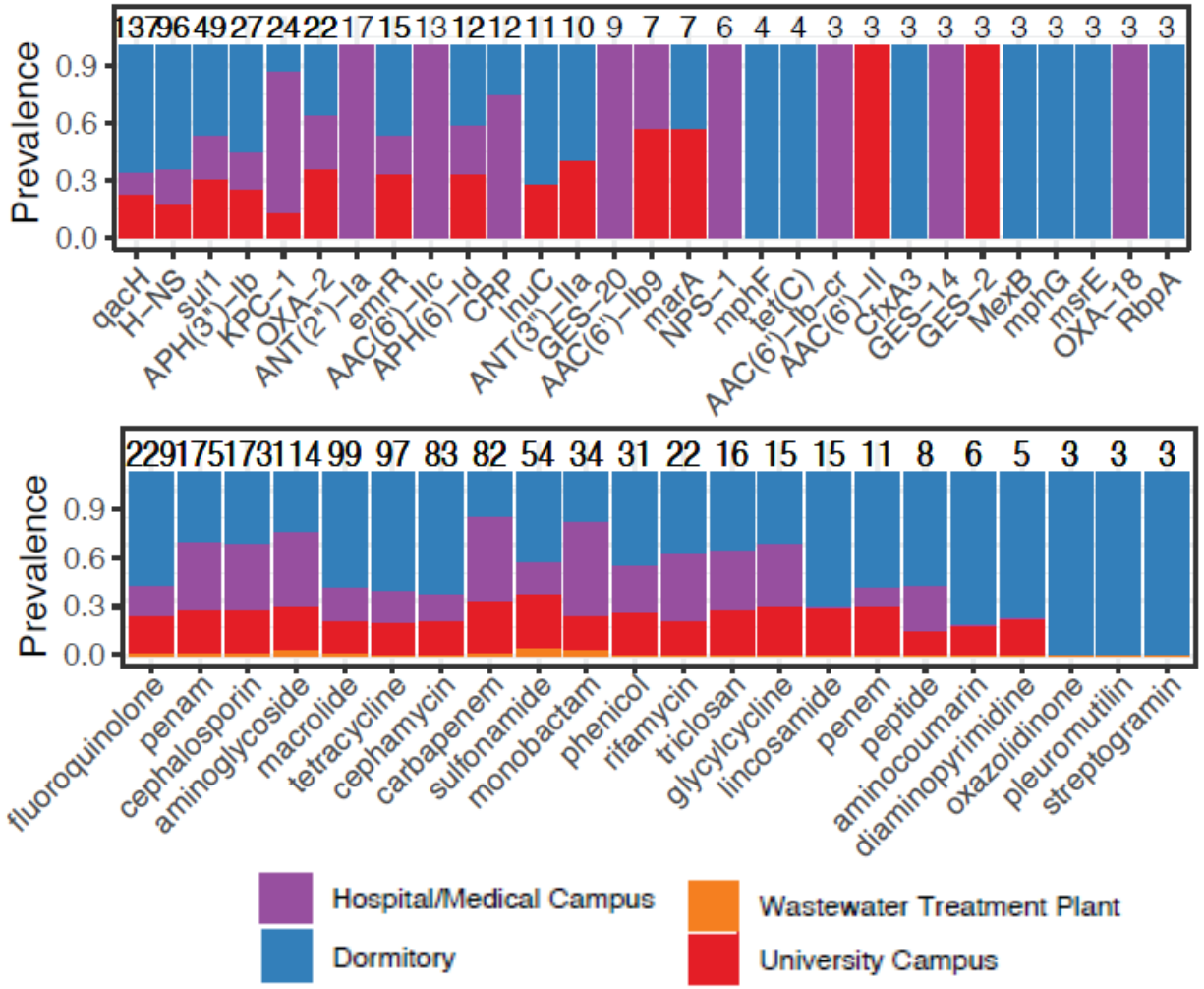
AMRs by site



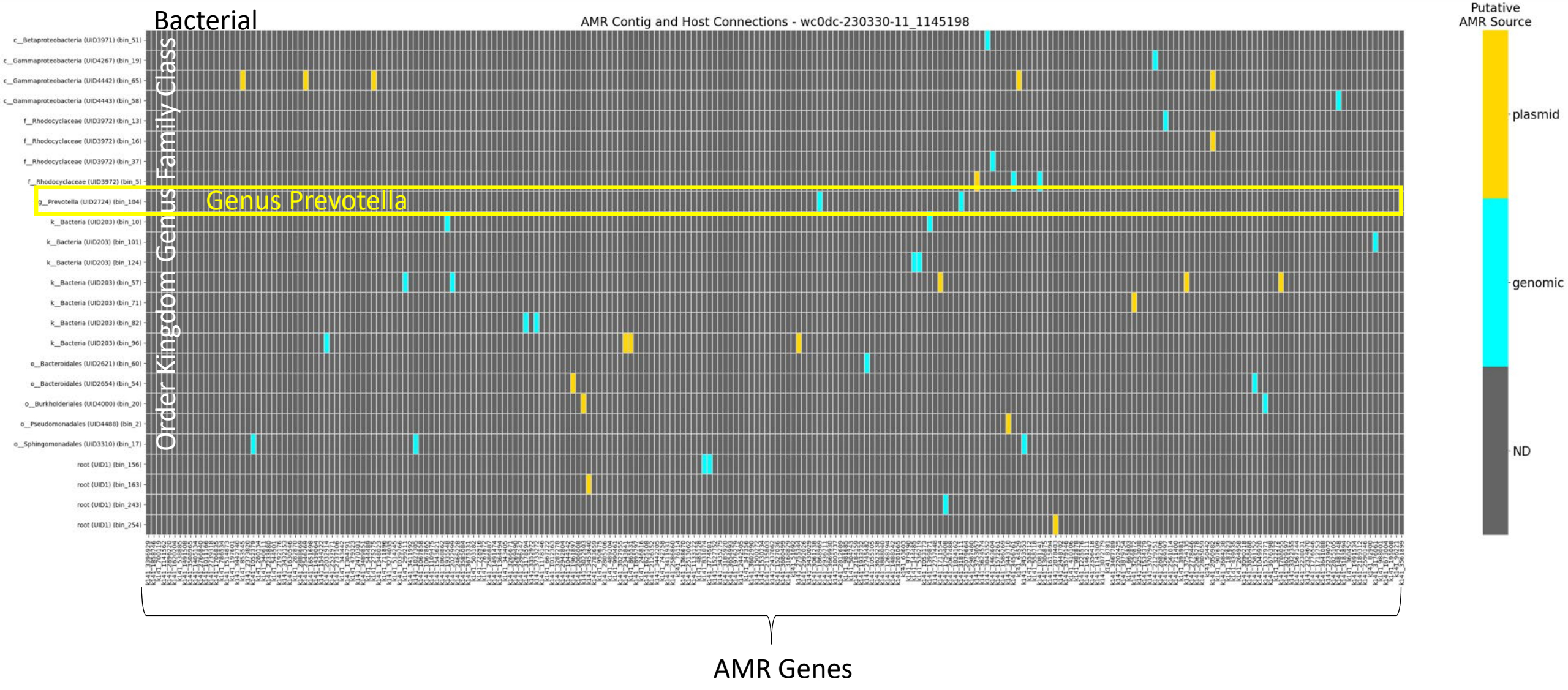
AMRs by month



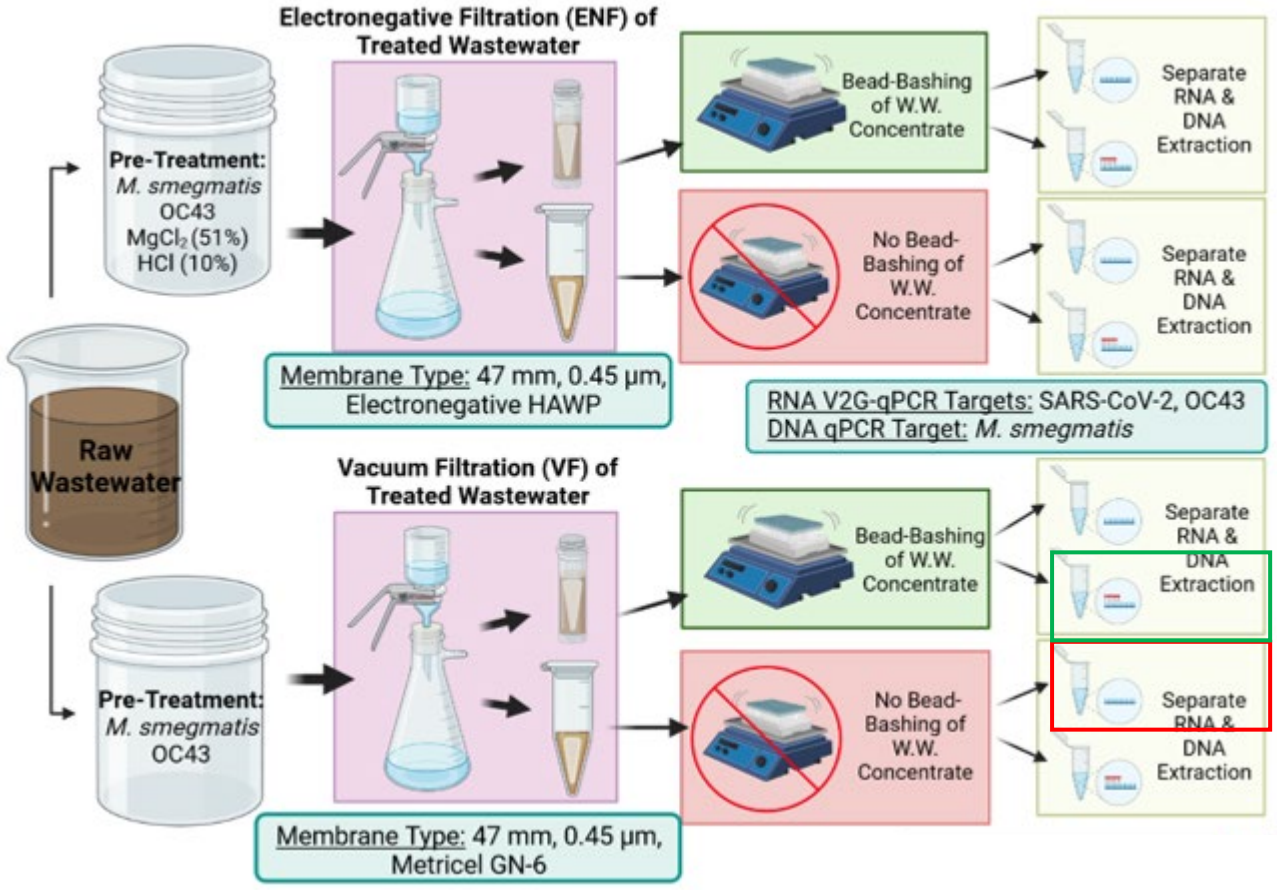


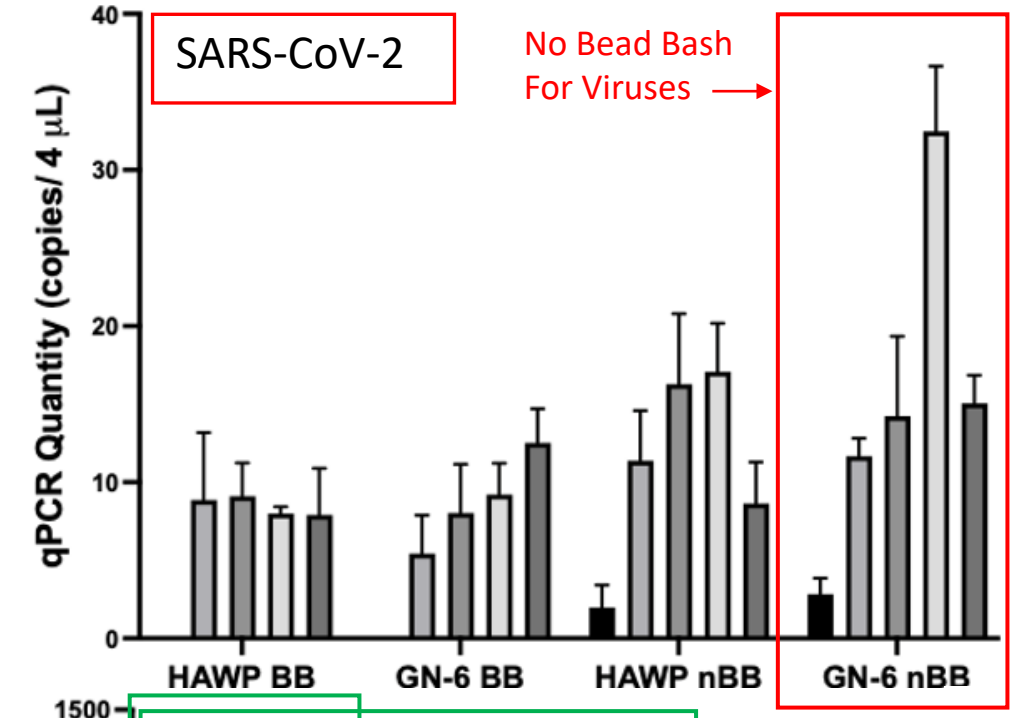
Weill Cornell Medicine

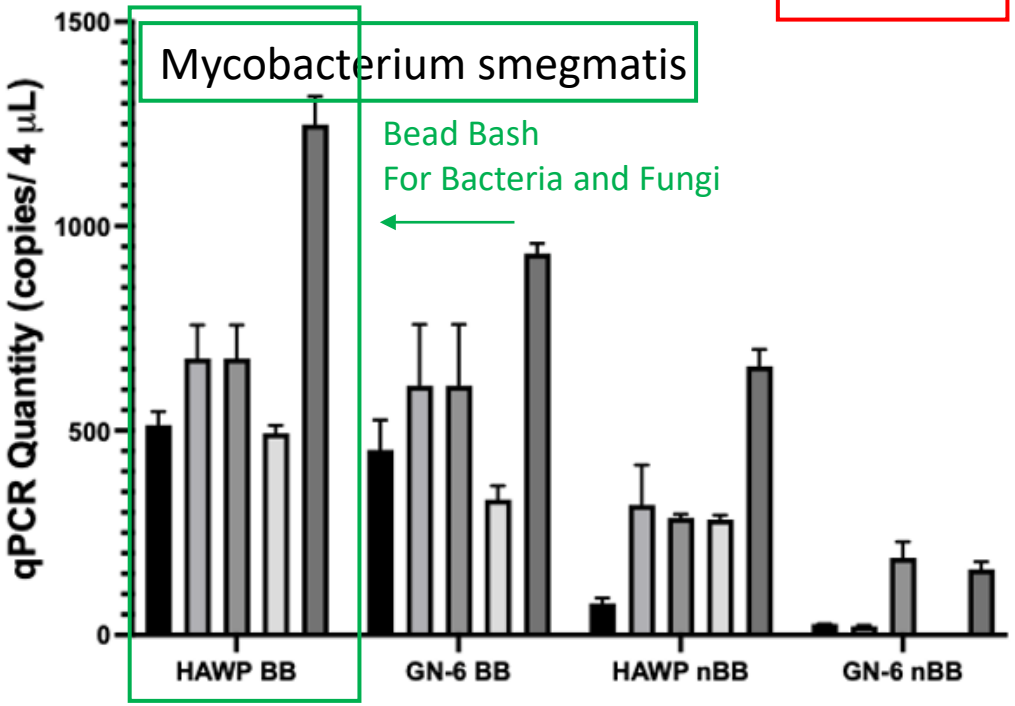
Host Attribution for AMR Genes in WW



Expansion of Workflows







Next Steps

Thank you

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- Targets beyond SARS-CoV-2 with expanded workflows (include air/surface)
- Potential for target agnostic approaches
- Challenges in interpreting what it all means
- Need to confirm with clinical data
- Automation of data assimilation and informatics

References

Short title	Author/Year	DOI
Lessons Learned	Sharkey et al. 2021	https://doi.org/10.1016/j.scitotenv.2021.149177
Air, Swabs, Wastewater	Solo-Gabriele et al. 2023	https://doi.org/10.1016/j.scitotenv.2022.159188
Wastewater and Clinical Cases	Zhan et al. 2022	https://doi.org/10.1021/acsestwater.2c00045
Wastewater, Cases, Hospitalizations	Zhan et al. 2023	https://doi.org/10.1021/acsestwater.3c00032
Compare Concentration/qPCR	Babler et al. 2022	https://doi.org/10.1021/acsestwater.2c00047
Expansion of Workflows beyond	Babler et al. 2023	https://doi.org/10.7171/3fc1f5fe.dfa8d906
Degradation of Molecular Signals	Babler et al. 2023	https://doi.org/10.1016/j.scitotenv.2023.161423
LAMP	Moore et al. 2021	https://doi.org/10.7171/jbt.21-3203-017
LAMP-TINY	Mozsary et al. 2021	https://doi.org/10.7171/jbt.21-3203-019
Mpox in wastewater	Sharkey et al. 2023	https://doi.org/10.1016/j.scitotenv.2023
C. auris in wastewater	Babler et al. 2023	https://doi.org/10.1016/j.scitotenv.2023.165459
Targeted and shotgun sequencing	Tierney et al. 2023	https://doi.org/10.1101/2023.05.31.23290781
Daily wastewater measurements	Abelson et al. 2023	https://doi.org/10.1101/2023.07.12.23292570